Computer Generated Forces at the Warfighter Training Research Division

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ABSTRACT: *The Air Force Research Laboratory (AFRL) is exploring a new concept in its training called Distributed Mission Training (DMT) that will build toward the Air Force (AF) service-specific synthetic battlespace (SB). DMT is a shared training environment comprised of live, virtual, and constructive simulations that allow warfighters to train individually or collectively at all levels of war. At the Warfighter Training Research Division of Air Force Research Laboratory at Mesa, AZ. the initial DMT vision has been developed and continues to evolve. The laboratory has a DMT test-bed that integrates virtual, live and constructive simulations for training and research applications. The test-bed has a full toolkit of constructive simulations including Computer Generated Forces (CGF). This paper will provide an overview of these constructive simulations and their use in DMT training and experiments.*

1.0 Introduction

The Warfighter Training Research Division (AFRL/HEA) in Mesa, AZ is part of the U.S. Air Force Research Laboratory's Human Effectiveness Directorate, within the Air Force Materiel Command (AFMC). AFRL/HEA is the USAF's premier organization for research and development (R&D) in warfighter training techniques and technologies. The division’s mission is to “develop, demonstrate, evaluate, and transition training technologies and methods to train warfighters to win." The mission is accomplished through an open, collaborative environment in which government, academia, and industry team with users and customers to develop and exploit new technologies, applications, and environments that will support the warfighter. The collaboration is designed to improve development, validation, and transition of needed training products to users, customers, and solution providers supporting the premise of "training the way we intend to fight" and recognizing that "training is the peacetime manifestation of war."

The integrated nature of war, high tech threats, and military operations other than war are creating a burgeoning training challenge for the USAF and joint forces. Coupled with the need to process extraordinary amounts of data and information, from sensor to Joint Forces Air Component Commander (JFACC) to shooter and back again, warfighters require seamless operational systems and peacetime integrated operations environments that will provide realistic mission training opportunities that currently do not exist. The need for realistic training is complicated by concerns of aging aircraft, training environment encroachment, expanding operations tempo, and cost. Classic individual procedural-based training must be supplemented by full-mission training to adequately prepare warfighters for the challenges of the 21st century. Consequently, the USAF has embarked on revolutionizing training initiatives that advocate affordable, realistic training environments to reduce the dependence on the aircraft as the primary training media. Modeling and simulation (M&S) are expected to provide on-demand, realistic training opportunities through an integrated operations environment

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14. ABSTRACT
The Air Force Research Laboratory (AFRL) is exploring a new concept in its training called Distributed Mission Training (DMT) that will build toward the Air Force (AF) service-specific synthetic battlespace (SB). DMT is a shared training environment comprised of live, virtual, and constructive simulations that allow warfighters to train individually or collectively at all levels of war. At the Warfighter Training Research Division of Air Force Research Laboratory at Mesa, AZ. the initial DMT vision has been developed and continues to evolve. The laboratory has a DMT test-bed that integrates virtual, live and constructive simulations for training and research applications. The test-bed has a full toolkit of constructive simulations including Computer Generated Forces (CGF). This paper will provide an overview of these constructive simulations and their use in DMT training and experiments.

15. SUBJECT TERMS
Computer-generated forces; CGF; Distributed mission training; DMT; Synthetic battlespace; Training environments; Live, virtual, and constructive; LVC; Simulation; Training;

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composed of live, virtual, and constructive training capabilities.

As new training systems are fielded, warfighters will be provided with expanded training capabilities, which will allow them to effectively and confidently reallocate training to the most effective venue. Since these systems will better replicate combat and operations other than war, they can be used to support future planning processes permitting the leadership to make better decisions regarding doctrine, strategy, and modernization.

As powerful as these new M&S tools will be, they can only be effectively used if all aspects of quality training are integrated with system development. AFRL/HEA's robust training R&D program is aimed at producing a research foundation upon which sound training system development principles can be based. M&S are a major part of AFRL/HEA's "tool kit," but it is AFRL/HEA's skilled scientists, engineers, computer scientists, and pilots who merge operational training systems information with R&D efforts.

Approximately 200 government and contractor personnel, on site and at remote locations, support AFRL/HEA's mission and form a diverse, multidisciplinary team of specialists. They include research psychologists, instructor pilots, human factors specialists, electrical and aerospace engineers, physicists, and computer specialists. This unique combination of research and development expertise enables the division to efficiently convert training needs into improved training methodologies and products. The division works closely with other Air Force, Navy, and Army laboratories, as well as with academia and industry.

2.0 DMT Concept

In the past, warfighter training depended heavily on the weapon and operational systems as the only realistic media for providing mission training. Now, with the dramatic improvements in the capability and affordability of advanced distributed simulation (ADS) technologies, warfighter training can be significantly improved at the mission and team level using the concept of DMT.

Distributed training allows multiple players at the same or multiple sites to engage in training scenarios ranging from individual and team participation up to full theater-level battles. It allows participation, using almost any type of networkable training device, including C2, from each weapon system and mission area. Additionally, computer-generated, or constructive, forces can be used to substantially enhance the scenario. This combination of live, virtual, and constructive environments allows nearly unlimited training opportunities for joint and combined forces from their own location or a deployed training site. This expanding capability will provide on-demand, realistic training opportunities for all warfighters unconstrained by the fiscal, geopolitical, legal, and scheduling problems associated with current real-world ranges and training exercises that limit training effectiveness and arbitrarily cap readiness levels today. DMT will dramatically improve the quality and quantity of warfighter training

3.0 DMT Testbed

The Multitask Trainer (MTT)/Unit Level Trainer (ULT) program was initiated specifically to address unit-level training. The unit environment requires reducing the life-cycle costs, space, power, and maintenance requirements of training systems while providing experienced warfighters with training systems that have the same fidelity and currency as their weapon system. A simulator at the squadron must provide individual standalone training, instructor-initiated training, and tactics, team, and mission training. All of this comes from the same device and control console. The MTT has provided high fidelity and concurrency through the use of converted aircraft operational flight programs (OFPs). It enables team training using local and long-haul networking, as well as sensor and weapons training via correlated sensor systems because its self-contained design. The MTT can be deployed to support forward operating locations.

Working in cooperation with the U.S. Air Force Reserve Command (AFRC) and Detachment 1 of Air Combat Command's Training Support Squadron, AFRL/HEA developed a successful team approach to MTT development. Detachment 1, located at Luke Air Force Base, designed and fabricated the F-16 MTT and C-130H3 ULT cockpits. Detachment 1 designs, builds, and maintains a wide variety of training devices and computer-based training lessons currently used in Combat Air Force (CAF) training programs throughout the world. Using state-of-the-art, computer-based equipment to design circuitry and manufacture structural components, Detachment 1 consistently ensures the design integrity, quality, reliability, and ease of maintenance of the training systems.

The MTT/ULT cockpit is functionally equivalent to its respective aircraft. The full-fidelity instrumentation and controls are essential for a complete range of emergency procedure (EP) training. A single MTT/ULT has the capability to train operational aircrews in a variety of skills. Networked with other MTT/ULTs, training impact can be multiplied for team training exercises and tactics. Figure 1 is an example of a DMT Test-bed located at AFRL Mesa, AZ.

Figure 1 DMT Testbed at AFRL Mesa, AZ

Such features make the MTT/ULT design eminently suitable for use in operational squadrons. Efficiency and reliability were very high during in-squadron testing of the F-16 MTT. Operating on three 20-amp, 110-volt power outlets in a standard office environment, the F-16 MTT requires no external support. It can be quickly dismantled and can pass through a 36" doorway for ease of transport. The F-16 MTT fits virtually any squadron setting and could accompany a unit to the combat zone.

In October 1993, the F-16 MTT went through extensive testing over a three-week period, and reached a major milestone of being the first deployable training device to be simulator certified by the USAF 29th Training Systems Squadron (TSS). Certification attests to the high fidelity and reliability of the MTT software and hardware.

To shortcut software development, the F-16 MTT/ULT uses existing Air Force-owned operational flight trainer (OFT) computer code along with aircraft OFP software from the aircraft systems' line replaceable units (LRU) provided by the aircraft logistics depot. Aircraft software was used by AFRL/HEA engineers to ensure a direct and maintainable correspondence of the trainer to the aircraft (a major concurrency issue). OFT and LRU software were converted to run at the same 50 Hz rate of the aircraft microprocessors. Use of government-owned software kept development risk and cost low while maintaining the highest level of simulation fidelity. It also ensured MTT/ULT concurrency with the aircraft as evidenced by re-certification of the F-16 MTT with the SCU-3 avionics upgrade fielded ahead of the aircraft SCU update.

As investment technology, the MTT/ULT program sets a new standard for cost-to-capability of simulators and allows for easy expansion for other aircraft. MTT/ULT projects target training requirements and exploits modern technology to achieve fidelity and concurrency. A-10 OFTs have been quickly recycled from bone yards using MTT architecture. The A-10 MTT was used to prototype other space-saving and increased-fidelity technologies such as new digital control loading devices which were then used in the C-130 ULT.

The C-130H3 ULT was designed to revolutionize training availability and quality for the heavy aircraft community. Existing simulators are expensive to procure and maintain, require specialized facilities and support, and are few in number for communities like the C-130. The C-130H3 prototype unit-level trainer includes an MTT-based, high-fidelity cockpit; the latest in graphical user interface (GUI) operator consoles; state-of-the-art commercial off-the-shelf (COTS) hardware technology; and is designed to fit in existing squadron facilities. Although not quite as mobile as the F-16 MTT, the C-130 ULT has been designed for modular assembly with quick disconnect points for rapid deployment to any needed location. It was deployed in April of 1997 to the Air Force Association's 50th Anniversary Exhibition in Las Vegas, NV.

Instead of treating F-16, A-10, and C-130 simulators as three separate and distinct training systems, the Air Force Research Laboratory, Mesa, Arizona, through its quality approach to training, standardized hardware components through the use of open systems architecture has networked the devices. Furthermore this approach allows for the seamless integration of reusable CGF. This approach is inexpensive and simple yet flexible and elegant for self-contained simulators. It also has greatly reduced the logistics required by users to support numerous unit-level, high-fidelity training systems. All MTTs and ULTs are designed with inherent local and long-haul networking capabilities to enable the devices to be used in joint service DIS/HLA exercises promoting greater interoperability among services.

With the F-16, A-10, and C-130 MTT/ULTs, AFRL/HEA is continually demonstrating how advanced technology can make state-of-the-art simulation/synthetic battlespace affordable and available to aircrews. The size and cost of the conventional F-16 simulator (OFT) has been reduced by a factor of 10, and the C-130 ULT will be higher fidelity than the Weapons System Trainer (WST) at approximately one-third the cost. Fidelity, combined with the compactness of a simulation system that is self-contained with all computational systems, input/output linkages, control loaders, cooling and operator console, and modest power requirements make the MTT/ULT mobile, flexible, and affordable.

4.0 Computer Generated Forces at AFRL

In order to provide both BLUFOR and OPFOR for the test-bed AFRL has three CGF initiatives: Automated Threat Engagement System (ATES) and Air Synthetic Forces (AirSF) CGFs both separately and as a hybrid system. These CGFs have been used for many exercises such as Warrior Flag, Coyote, Roadrunner and JEFX. A further initiative is the development of high fidelity threat models that can be used to stimulate actual avionics as well as act as realistic threats in a CGF system.

4.1 ATES

ATES is a Government Furnished Equipment (GFE) product available for use by any government project at no cost. It is intended for use in aircrew training. ATES is a hardcore 20HZ/50ms frame based real-time threat system for use on a DIS network. ATES focus's on medium size tactical engagements over a period of a few minutes to a several hours in length.

The missiles use the classified Air Combat Maneuvering Instrumentation (ACMI) models for accurate missile modeling. Chaff and Flares are modeled as additional targets that a sensor must discriminate from the target, not just a reduced probability of kill. The aircraft A/C models use true aerodynamic modeling to determine aircraft (A/C) flight paths. The A/C scenario scripting method based on conditions such as "RANGE to HOSTILE" or "ASSIGNED TARGET" or "TIME" allows more realistic interaction with Man in the Loop virtual simulators than with time only based conditions. This scripting also allows setting up known difficult situations for aircrews to train against, exploiting known cockpit limitations. Headquarter (HQ) tactical situation assessment simulation allows ATES to react to the current tactical environment making reactions of players more realistic and credible than scripted only A/C scenarios. Multiple ATES may run on a DIS network simultaneously if more entities are desired. New VME boards (300 MHz Power PC's) are available that would increase the number of simultaneous entities that could be generated by a single ATES configuration.

ATES operates on one 120 MHz Power PC VME board with 64MB of memory running the VxWorks real-time operating system for ATES. This allows approximately 40MB of memory for terrain data, or around 13 terrain cells. One 120 MHz Power PC VME board with 16MB of memory running VxWorks real-time operating system provides the Network Interface Unit (NIU). One 4 slot VME chassis is required. Normally one SUN workstation is used to download software to the VME boards.

ATES can simulate up to 40 six (6) degree of freedom high fidelity aircraft simultaneously. The aircraft model includes the following characteristics:

- Employs true aerodynamic modeling for A/C performance, including an atmospheric model.
- Employs data parameters to define A/C thrust tables, drag, etc for different A/C types which allows accurate performance modeling at all altitudes for various A/C.
- Current A/C aerodynamic data parameters exist for the F16, F15, MIG29 and SU-27.
- Artificial limits on G's, roll rate, speed etc in the scenario files may be used to allow aerodynamic models to be used to create KC-135 like flying characteristics for tanker tracks, or other A/C for which correct performance and aerodynamic modeling is not considered critical.

The aircraft may fly scripted flight paths, or follow a list of maneuvers with each maneuver having an end condition. Some possible end conditions are Range to Hostile, Range to Friend, Received Assignment, Time, Altitude, Location, etc. There are many basic maneuvers, including split, spiral, beam, turn to heading, offset, chase etc. A basic script might be fly Combat air patrol (CAP) points until a hostile gets within 40nm, then turn and fly east for 30 seconds then turn and attack, or fly cap until assigned a target, climb to 25000 feet, turn on your radar, then attack the assigned target.

A number of Surface-to-Air-Missiles (SAM) and Anti-Aircraft Artillary (AAA) are simulated. This includes 20 each of SA2, SA3, SA4, SA6, SA8, ZU23, S-60 57mm and ZSU23-4 systems. These entities are stationary and do not dynamically move in the data base.

Missile and bullet fly-outs use the full 6 DOF classified ACMI models for accurate results. IR seekers are modeled during missile fly-out. This allows proper modeling of maneuvering and flare counter measures on missile fly-outs.

Sensors models include A/C radar including scan volumes, radar range calculations, Doppler notch, RCS, and terrain masking. Effects for ground clutter are planned but not yet modeled. Radar Cross Section (RCS) is based on lookup tables. Current data in tables is generic. All sensor models are masked by terrain. The resulting emitting sensor information is transmitted onto the DIS network using the emission Protocol Data Units (PDU).

Terrain modeling uses standard Defense Terrain Data (DTED) level 1 data as the terrain database. It is possible to use as many DTED cells as available in memory as the hardware platform permits. Approximately 3MB of memory per DTED cell are required.

ATES also provides a command and control capability. ATES uses a three tiered hierarchy HQ, Battalion, Battery approach. Delays and messages are modeled between levels, allowing fairly good emission control and appropriate timings by the SAMs. HQ uses the information gathered from its radar's to try to evenly distribute RED air assets against BLUE A/C, on a continual basis throughout a scenario. Any A/C, SAM, or AAA may also operate in an autonomous fashion.

Scenarios are created and edited using a basic ASCII text file. Some practice and training are required to effectively perform scenario generation. Scenarios are selected from a DIS network controller using the DIS SET DATA PDU. Scenarios are started and stopped by the DIS network controller. Scenarios may be monitored using any DIS "God's eye" view display.

ATES is intended for use on a DIS network. It does not have it's own Graphical user Interface (GUI), because there are many DIS "God's Eye" view monitors available to be able to see DIS traffic. The running of pre-created scenarios may be requested at any time over the Network using the standard DIS SET_DATA PDU. ATES is able to process up to 60 A/C entities from a DIS network. ATES does not currently interact with ground based network entities, or emissions. There is ongoing work to enable the ATES to be HLA compliant, using the RPR FOM.

4.2 AirSF

The AFRL in conjunction with the Defense Advanced Research Projects Administration (DARPA) has added Air Synthetic Forces (AirSF) to their battlespace inventory of threat and CGF systems. This Modular Semi-Automated Force (ModSAF) based, beyond visual range Government Off The Shelf (GOTS) CGF provides high fidelity autonomous behaviors of a synthetic force for the majority of AF roles and missions as well as opposing forces. AirSF provided computer-generated air forces for a DOD advanced concept technology demonstration (ACTD) called Synthetic Theater of War, 1997 (STOW-97) which was a constructive simulation. The integration of AirSF in a distributed environment to the virtual simulators (F16's, A10) at AFRL has been demonstrated in exercises such as Road Runner 98.

AirSF is part of the STOW Joint SAF which included ground and maritime assets. It is distributed PC based CGF using a LINEX operating system. By adding PC's the total number of entities can be expanded depending on exercise requirements. Currently 15-20 highly intelligent high fidelity agents require one PC. Recent experiments for Army applications have used combinations of high fidelity and lower fidelity behaviors to support over 2000 entities.

The Distributed Mission Training (DMT) concept to train in complex environments and battlespaces will continue to expand as advanced weapon and information technologies develop. Synthetic or computer generated forces are a critical component of this joint synthetic battlespace. The synthetic forces are necessary to fully populate the joint synthetic battlespace for training, weapon system development, tactical analysis, and mission rehearsal. The integration of AirSF to the virtual simulators at AFRL provides an initial capability of this population with highly intelligent synthetic agents that can supplement ATES.

Entities from AirSF perform their missions autonomously and integrate seamlessly to the virtual simulators. Once briefed they plan and execute their missions in conjunction with the virtuals using appropriate doctrine and tactics. Minimal human supervision is required of AirSF; however, entities may be re-tasked through radio/voice commands that replicate human communication. Currently the virtuals do not have control over the AirSF entities with the exception of a within visual range synthetic wingman that uses voice control techniques which will be discussed later.

Even though each entity is autonomous, they are not acting in isolation. Individual entities coordinate their actions using existing doctrine and C^4I systems. They use shared knowledge of doctrine, tactics, and mission objectives as well as explicit radio communication to achieve common goals. As the mission develops, entities may change roles dynamically as in the real world.

AirSF provides behaviors for most commonly flown air roles and missions including: air-to-air, air-to-ground , control , reconnaissance, and refueling, It can provide friendly, opponent, or neutral forces.

The exercise editor meets the need for scenario generation, with much less manpower than conventional simulations. The exercise editor is a GUI that is used to create the missions. The exercise editor is hierarchically organized so shared information need only be entered once. Although not applied at AFRL the Automated Wing Operations Center (AWOC) can integrate to existing mission planning systems (CTAPS) to populate the majority of the mission data base automatically over the network. AFRL will incorporate the next generation mission planning system, Tactical Battle Management Core System (TBM-CS), for that function in the future.

As the entities perform their missions a simulation operator may want to modify mission parameters. The communication panel provides a graphical interface for sending pre-formated simulated radio messages. The radio log tracks and displays radio traffic on an agent's active radios. AirSF also provides an ordinance server (OS) for weapon flyouts and SoarSpeak to provide voice commands for controlling the intelligent agents.

SoarSpeak uses natural voice recognition and speech generation to direct and interact with synthetic, constructive entities controlled by the AirSF air behavior system. This allows such synthetic entities to maintain autonomy, flexibility and realism. Rather than requiring a system operator to manually intervene to change an entity's behavior, SoarSpeak allows relatively untrained users to retask aircraft via voice directives.

SoarSpeak provides zero latency, interactive voice communication over computer data networks. It uses commercial off the shelf IBM Via Voice technology with advanced state-of-the-art continuous speech recognition and runs on minimal hardware configurations under Windows 95, 98, and NT. It has been tailored to understand military aviation communications and was demonstrated in COYOTE '98.

Figure 2 illustrates the typical AirSF configuration.

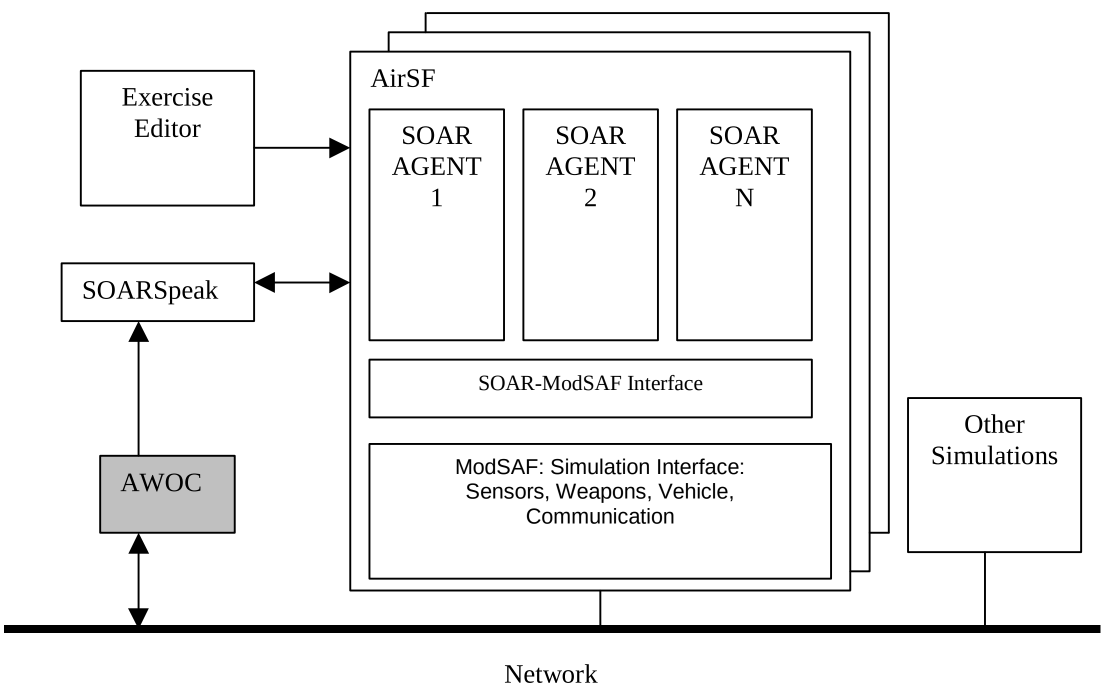

Figure 2 Typical AirSAF Configuration at AFRL

4.3 Electronic Warfare Simulation

The Warfighter Training Research Division of the Air Force Research Laboratory is developing an electronic warfare simulation model that enables aircrews to participate in the full spectrum of electronic warfare using simulators. Current simulation and CGF technology limits electronic warfare training to basic cockpit procedures, that is, the operation of the EW avionics, and signal recognition. These are essential tasks that must be mastered; however, training that depicts actual combat missions requires simulations that permit threat entity models to operate with the same performance characteristics associated with actual entities. This requires a simulation that not only models the threat entities, but also the environment in which these entities operate.

It is the environment model that distinguishes this model from those currently used. The environment model dynamically calculates terrain clutter, infrared background clutter, and weather effects and provides this data to the threat entities, which allows these entities to operate with randomly varying performance capabilities, reflecting real-world operation. The application is for advanced CGF physical/environmental models and realistic stimulation of radar warning avionics in virtual simulators.

4.4 Hybrid Systems

AFRL uses combinations of CGF and constructive simulations for most of the exercises. For example AirSF is used for strike packages while ATES is employed for air-to-air combat. AirSF participated by flying battlefield interdiction and suppression of enemy air defense missions, in which humans in simulators flew air-to-air escorts. AirSF also engaged humans in virtual simulators acting as opponent air forces. Overall, TacAir-Soar flew 174 missions.

Furthermore, some scenarios are also supplemented by long haul distributed CGF such as Theater Command and Control Simulation Facility (TACCSF) Stage CGF system. The end result is a highly interactive hybrid CGF that leverages off each CGF's best features.

An example of the use of various constructive simulations that were integrated at AFRL was RoadRunner 98. RoadRunner 98 was a DMT exercise conducted in July 1998 with the goal of defining the state of the art in DMT technologies and exploring how to best use this new training environment. The objective of RoadRunner 98 was to conduct composite force missions using virtual (warfighter-in-the-loop) and constructive (computer generated) simulations over a wide area network in order to document the technical capabilities necessary for combat mission training and to evaluate strategies for training effectiveness research. RoadRunner 98 was sponsored by the Air Force Modeling and Simulation Office with AFRL/HEA serving as program managers, the TACCSF, Kirtland AFB, New Mexico, as systems integrators, and research support from the Naval Air Warfare Center—Training Systems Division. The warfighters who participated in RoadRunner 98 were operational pilots from New Mexico, Iowa, Arizona, and Florida working together with Airborne Warning and Control Systems (AWACS) crews from Oklahoma. Teams of warfighters flew composite force missions over a synthetic Red Flag Training Range. Each mission was executed over a secure, wide-area network using DIS communications protocols. In these missions, virtual players interacted with constructive forces including friendly and enemy fighters, helicopters, and ground vehicles, plus enemy surface-to-air threats. Five of the seven composite force missions were offensive air-to-surface, one mission was defensive air-to-air, and the last was close air support. The intent of RoadRunner 98 was to provide operational warfighters with the opportunity to experience DMT using state-of-the-art systems. Based on their experience, participants were asked to identify the technical successes and shortfalls in these systems and to assess the potential for DMT to improve future Air Force training. The forces in RoadRunner 98 missions are listed in Table 1.

Table 1 RoadRunner 98 Entities

Virtual Simulations	
4 F-16s 1 A-10	AFRL, Mesa AZ
4 F-15s 2 MiG-29s	TACCSF, Kirtland AFB, NM
AWACS • 2 Weapons Directors • 2 Air Surveillance Technicians	Tinker AFB, OK
Constructive Simulations	
E-3 AWACS	TACCSF
Surface-to-air missiles (SAMs), radars, command & control	Air Force Information Warfare Center, Kelly AFB, TX
Blueair (ATES, AirSF) • F-16 block 30 • F-16 block 50 • KC-135, helos	AFRL, Mesa AZ
Red air • MiG-29s	AFRL, Mesa AZ

• Su-27s, helos	
Other entities • M-1, T-72 tanks • Anti-aircraft artillery (AAA)	AFRL, Mesa AZ

5.0 Conclusions

The DMT testbed employs a wide variety of CGF and constructive simulations for aircrew training research. These assets are used in hybrid systems to provide highly interactive synthetic battlespaces in the support of large scale research and training exercises such as Roadrunner.

6.0 References

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Author Biographies

GARY R. GEORGE is a Principle Systems Engineer at L-3 Communications with over twenty years of experience in simulation and modeling. Over that time he has published several papers on a wide variety of simulation topics. Mr. George recently has been a consultant to AFRL for computer-generated forces. He holds a B. S. in Mechanical Engineering, a M. S. in both Mechanical and Electrical Engineering at the State University of NY and Syracuse University. He is currently a Ph.D. candidate at Binghamton University performing research on human perceptual modeling. He has been awarded the Link Foundation and ITSEC fellowships.

JOHN H. FULLER is the L3 Communications Program Manager for the Warfighter Training Research contract at the AFRL Mesa location and for the Flight Simulation Facility Support Services contract at Wright Patterson AFB, Ohio. He has over 3000 hours as an USAF pilot in special and conventional operations, and has over twelve years experience in training and simulation research. He is an active participant in Interservice / Industry Training, Simulation, and Education Conference committees and has chaired special sessions for the last two years on current research experiences in the DMT environment. He holds a B.S. in Engineering Science from the USAF Academy and a M.S. in Astronautical Engineering from Purdue University.

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Agenda

- Introduction to AFRL
- DMT Concept
- DMT Test-bed
- CGF at AFRL
- Hybrid Systems
- Conclusions

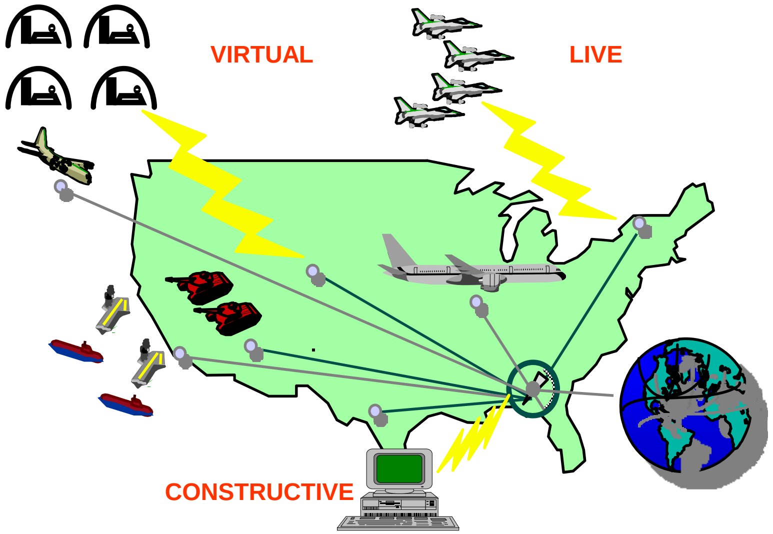
Warfighter Training Research Division

- Part of AFRL Human Directorate Division
- Premier Organization for R&D in Warfighter Training Techniques and Technologies
- About 200 Engineers and Scientists form Warfighter Team
- L-3 Comm., L-M, Boeing support contractors

DMT Vision

- Insufficient exercise $$
- Reduced flying time
- Security issues
- High PERSTEMPO, OPSTEMPO
- Safety
- Airspace availability
- Restricted weapons/EW envelopes
- Environmental concerns
- Complex rules of engagement

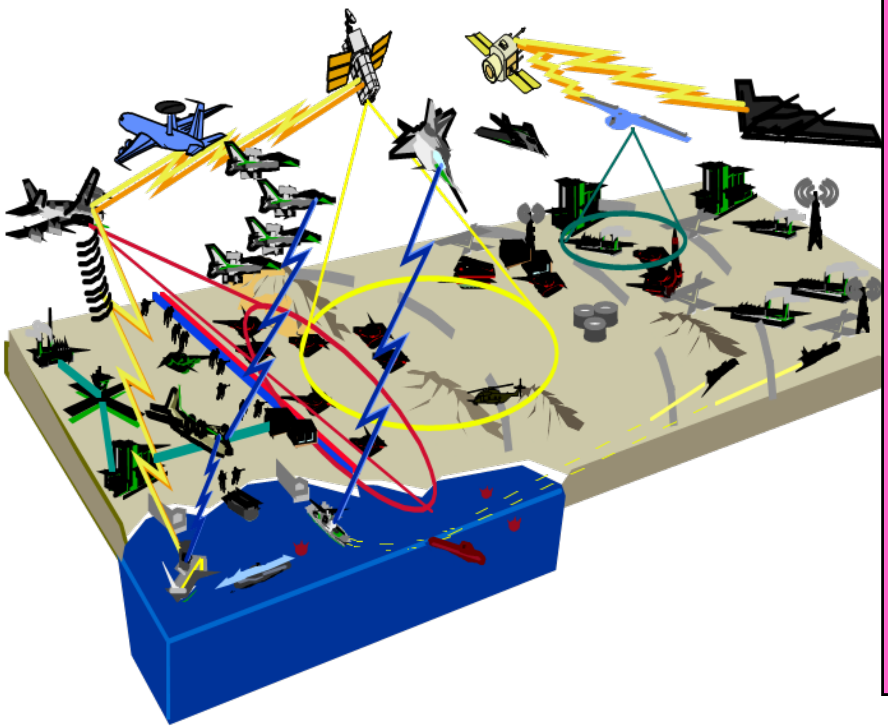
We fight as an Air & Space Team, but we seldom train together as a Team



DMT Test-bed

- Multitask Trainers
- F16, A10, C130H3 Cockpits
- Emulated OFP’s
- Standardized HLA Network
- Used for Many Experiments and Exercises
- Includes LHN and LAN
- Uses Hybrid System of Computer Generated Forces
- Includes Highly Autonomous Behaviors
- Advanced Threat Models

CGF at AFRL Warfighter Research Training Division



- Lab has three in-house CGF assets to support the DMT Test-bed
- Uses LH assets as well
- Provides BLUFOR and OPFOR
- Automated Threat Engagement System (ATES)
- Joint SAF (JSAF/AirSF)
- Electronic Warfare Simulation

Automated Threat Engagement System (ATES)

- GFE 20Hz real time threat system
- Supports up to 40 6DOF Platforms
- Includes sensor and weapons models
- IADS include SA2, SA3, SA4,SA6, SA8, ZSU23, S-60, 57MM, and ZSU23-4
- Can fly scripted paths or a list of maneuvers
- Combines C2 information
- Scenarios developed by editing ASCII text files

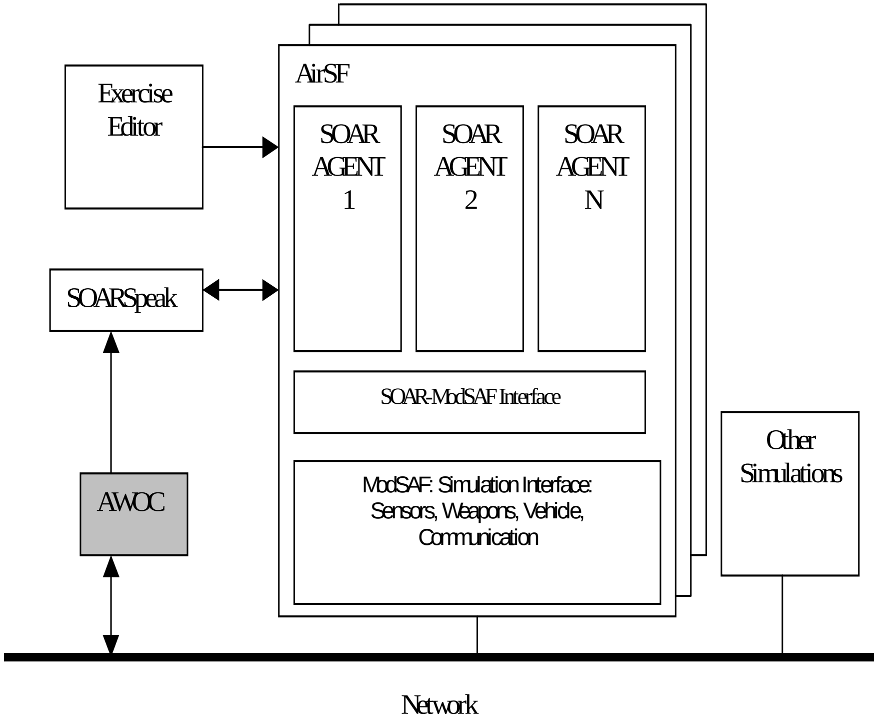
ATES (Continued)

- Sensors include A/C radar scan volumes, range calculations, RCS and terrain masking
- Uses DTED terrain data.
- DIS Compatible
- Pilot evaluated
- Has been continually upgraded as it matures over the years
- Uses other PVD's on network rather than didicated GUI
- Models from advanced EW modeling could be added

JSAF (AirSF)

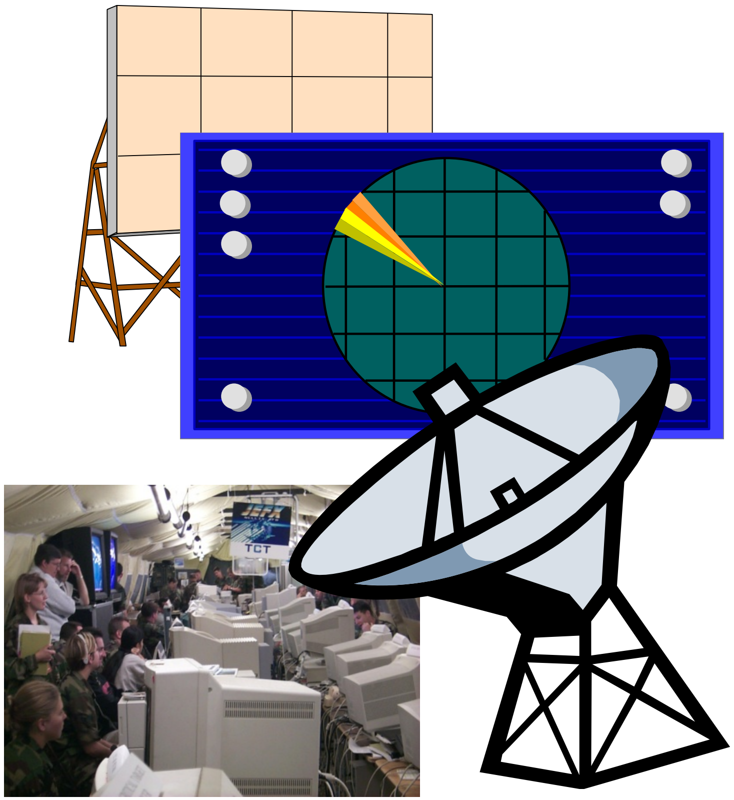
- Part of STOW Synthetic Battlespace
- Used in a number of exercises at AFRL
- Based on expert systems SOAR
- Uses ModSAF for physical entities

JSAF (Continued)



- Incorporates an exercise editor for scenario generation and control
- Employs SOAR Speak for voice control of CGF
- Entities perform missions autonomously and integrate seamlessly to virtuals

Electronic Warfare Simulation



- Current CGF models are weak in the EM spectrum
- Many limit training to cockpit procedures
- AFRL is developing advanced models of threats that portray true EW performance
- Used to stimulate actual or emulated avionics in virtuals
- Includes clutter, background effects and weather effects

Hybrid Systems

- AFRL uses combinations of CGF
- Leverage off the best qualities of each CGF
- Combines LH and local assets depending on exercise
- Use AirSF for strike packages and ATES for A-A
- Road Runner Exercise a good example…………….

Hybrid Systems (Continued)

Virtual Simulations

- 4 F-16s, 1A10, 4 F-15's AFRL, Mesa AZ
- 2 MiG-29s TACCSF, Kirtland AFB, NM
- AWACS

  2 Weapons Directors

  2 Air Surveillance Technicians Tinker AFB, OK

Constructive Simulations

- E-3 AWACS TACCSF
- Surface-to-air missiles (SAMs), radars, command & control

  Air Force Information Warfare Center, Kelly AFB, TX
- Blueair (ATES, AirSF) AFRL, Mesa AZ

  F-16 block 30

  F-16 block 50

  KC-135, helo
- Red air (ATES, AirSF) AFRL, Mesa, AZ.

  MiG-29s

  Su-27s, helos
- Other entities AFRL, Mesa AZ

  M-1, T-72 tanks

  Anti-aircraft artillery (AAA) AFRL, Mesa AZ

ROADRUNNER '98

REAL-TIME TRAINING...ONE BYTE AT A TIME

Conclusions

- AFRL Continues to evaluate the latest in CGF technology and evolving systems….JIMM, OneSAF etc.
- The DMT Test-bed provides an excellent avenue to evaluate CGF in full exercise environment